US EPA ARCHIVE DOCUMENT

AED Peer Review '07

Assessing Coastal Wetland Condition and Avifauna Response (WQ MYP)

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ncy Problem

A's Office of Wetlands, Oceans, and Watersheds has called for
h to support the development of scientifically sound methods
ls to assess coastal wetland condition. These methods and tools
ow reporting of the ambient condition of coastal wetland
es (compliant with Clean Water Act § 305(b) – "State of the
s Waters"), assist in the identification of impaired wetlands, and
t the development of tiered aquatic life use support criteria for
ds to assess compliance with designated uses. Our research is
ing the underlying science needed by the Office of Wetlands,
, and Watersheds to aid in reporting and criteria development

eloping scientifically sound methods and tools to assess coastal
and condition

ermining how stressor levels, biological-response relationships, and
ssessment methods can be applied across U.S. wetlands to set
ria for restoration and protection of wetlands relative to use
gnations

eloping models that describe relationships between anthropogenic
sors and biological responses in coastal wetlands of the
eastern United States

earch Goals

reate a scientifically-based tool that can determine the condition
ew England coastal wetlands in a rapid, cost effective manner.

nk the condition of the wetlands with habitat quality, avifauna,
wildlife use of the wetland.

hods & Approach

a 3-tiered approach (Figure 1), the coastal wetlands in New England
ssessed with (1) a landscape analysis, (2) a rapid field method, and
tailed field evaluation for some targeted, reference sites. The
d field evaluation allows calibration and verification of the landscape
id methods (Tiers 1 and 2). Over 60 wetland units were selected
out CT, RI, and MA using a random design with sampling spread
ire coastlines using a hexagon scheme.

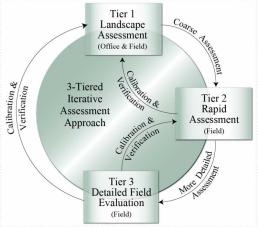
e landscape analysis (Tier 1) used available inventory maps of
ertidal, emergent and associated wetlands, aerial photography, and a
eographic Information System to assess condition of the wetlands and
sturbances (*e.g.*, ditching, fragmentation, barriers to landward
igration) at a coarse scale.

the second assessment tier, the condition of the wetland was
scribed through a field evaluation using measures of hydrology,
nts, and soil. The plant metrics included descriptions of
mmunities, species, and percent cover. Soil metrics included
easures of penetration resistance and macro-organic matter or peat
gment content in the surface layer of the soil. Areas of disturbance
ch as tidal restrictions, outfalls, and invasive species were also
served on-site.

the final tier, detailed biological (*e.g.*, waterfowl, salt-marsh-obligate
ds, fish, infauna) and geochemical measurements were made at a
geted subset of reference sites of low to high watershed disturbance
indicated by land use and watershed nitrogen inputs. Upon
mpletion of the assessment, a reference-based evaluating scheme will
developed to describe the relative condition of the coastal wetlands.

Collaborators: The US EPA, Atlantic Ecology Division and Region 1 are working collaboratively with the Massachusetts Coastal Zone Management, the Narragansett Bay Estuary Program, Yale University, and the University of Rhode Island to implement landscape and rapid assessments of coastal salt marshes in Rhode Island, Massachusetts, and Connecticut. These partnerships help ensure that the research results will be used by clients.

Figure 1. Three-Tiered Iterative Assessment Approach



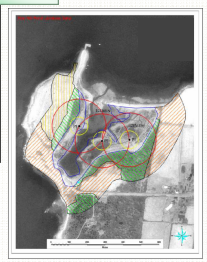
Tier 1. Landscape Assessment
(requires 1 day in the office & site visit)

Characterization

- Landscape position
- Size
- Shape
- Exposure
- Slope

Disturbance

- Watershed land use
- Ditching / draining
- Fill & fragmentation
- Point sources
- Barriers to landward migration
- Tide restriction/ hydrological alteration



Tier 2. Rapid Onsite Assessment
(requires 3-4 hours per site)

Condition

Plants
- Plant Species
- Plant communities
- Invasive plants

Soil
- Penetration resistance
- Below ground plant fragments

Hydrology
- Tidal flushing

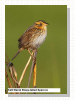
Tier 3. Detailed Field Evaluation
(ongoing research)

Ecological Function
- Denitrification
- Soil respiration

Plant Structure
- Plant species
- Productivity
- Extent and morphology

Soil Structure
- Peat volume
- Root morphology
- Root volume

Avifaunal Response
- Bird use of riparian wetlands
- Wildlife Habitat Value Assessment



Research Results

Figure 2. Conceptual model describing the mechanisms for changes in marsh structure and function due to increasing loads of watershed nitrogen

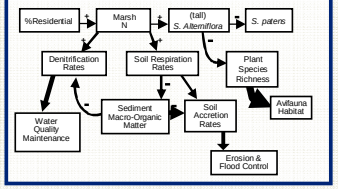
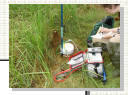


Table 1. Summary of some field results examining ecological structure of salt marshes subject to varying loads of nitrogen. (All listed correlations were significant at P < 0.05)

Relationships with N-load	Correlation Coefficient (r)	Expected marsh response to N- enrichment
tall *S. alterniflora* (extent & density)	+0.77 +0.76	▲
Plant species richness	-0.73	▼
S. patens (extent & density)	-0.74 -0.73	▼
Infaunal deposit-feeders	+0.74	▲
Ribbed mussels (density & biomass)	+0.90 +0.72	▲



Examples of Detailed Field Evaluations (Tier 3)

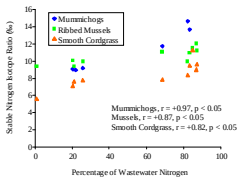
Ecological Structure

Table 2. Watershed description and calculated nitrogen loadings, for ten Narragansett Bay coastal fringe marshes.

	Watershed			Calculated Nitrogen Loads		
*Site	Watershed Area, ha	Percent Residential	Marsh Area, ha	Total N-load, Kg N ha⁻¹ y⁻¹	Percent Watershed	Marsh N-load, Kg N ha⁻¹ y⁻¹
JEN	41	4.0	12	29	37.4	2
FOX	62	0.3	10	103	2.3	10
FOG	30	14.9	4	280	25.0	63
DON	2975	10.0	29	11593	30.2	400
PAS	314	65.4	4	9917	82.2	2418
BRU	781	61.8	9	22344	81.9	2440
BIS	2296	22.1	4	11235	62.6	2922
OLD	1505	44.5	10	31587	79.1	3282
WAT	402	56.0	2	11920	70.0	6037
APP	1738	43.3	3	32472	74.5	10253

*Sites are listed lowest to highest marsh N-load
- JEN = Jenny Pond
- FOX = Fox Hill Salt Marsh
- FOG = Fogland Marsh
- DON = Mary Donovan Basin
- PAS= Passeonkquis Cove
- BRU = Brush Neck Cove
- BIS = Bissel Cove
- OLD = Old Mill Creek
- WAT = Watchemoket Cove
- APP = Upper Spectacle Cove

Figure 3. Relationships of the stable nitrogen isotope ratios of mummichogs, ribbed mussels, and smooth cordgrass with the wastewater fraction of the watershed nitrogen loads.



Changes in the plant structure (Figure 4) in reference coastal salt marshes having a range of watershed development and nitrogen loads (Table 2). These response data provide a reference data set to calibrate more coarse rapid assessments and verify the accuracy of the rapid assessment plant methods (Figure 5).

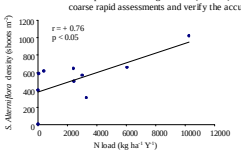


Figure 4. Relationship between watershed nitrogen loads and marsh plant structure

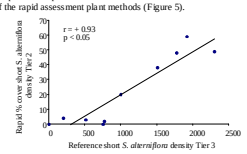


Figure 5. Relationship between Rapid % cover and reference density of short *S. Alterniflora*

Ecological Function

Figure 6a. Fall high marsh denitrification potential in Narragansett Bay saltmarshes.

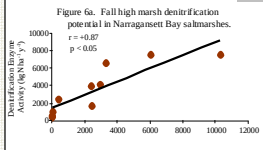


Figure 6b. Summer high marsh nitrogen flux in Narragansett Bay saltmarshes.

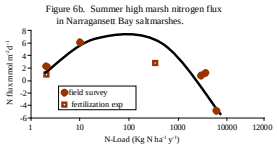


Figure 7. Relationship between soil respiration rates and watershed nitrogen loadings in Narragansett Bay salt marshes.

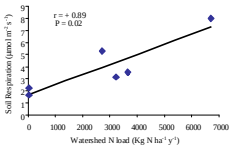
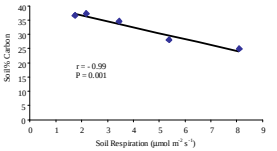


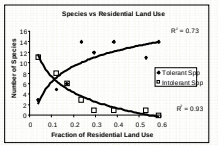
Figure 8. Relationship between soil respiration rates and soil percent carbon in Narragansett Bay salt marshes.



Avifaunal Response

1) Bird use of riparian wetlands

This study assessed the relationship among land use, riparian vegetation, and avian populations at two spatial scales. Our objective was to compare the vegetated habitat in riparian corridors with breeding bird guilds in eight Rhode Island subwatersheds along a range of increasing residential land use. Riparian habitats were characterized and bird surveys were conducted in the riparian zone of streams feeding into reference coastal salt marshes having a range of watershed development.



- Total vegetative cover (reach scale) decreased at all layers (tree, shrub, ground) as residential land use increased.
- The best vegetation indicators related to breeding bird populations at the subwatershed scale were: acres of riparian zone, edge:area ratio, % forest, %forest + wetland, and % canopy.
- Intolerant bird species (including forest-interior species) declined significantly at 20% residential land use and 5% impervious surface, while tolerant species (including forest-edge species) increased.

Figure 9. Shifts from intolerant to tolerant bird species with significant R^2 values (log regression) occurred with increased percent residential land use.

2) Wildlife habitat value assessment

We used a two step process to develop an assessment model to quantify the habitat value of New England salt marshes for terrestrial wildlife based on specific habitat requirements of resident species. The first step involved development of a framework outlining the necessary model components and types of data needed for the assessment. In the second step, a ranking system was developed and tested with data acquired from a reference network of salt marshes located along a disturbance gradient.

Figure 10. Location of the16 study site salt marshes in Greenwich Bay, RI.

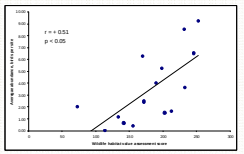


Figure 11. Model validation: average abundance of Ardeidae (herons and egrets) versus wildlife habitat value assessment score at 16 salt marshes in Greenwich Bay, RI.

- Assessment scores ranged from 37 – 61 % of the maximum attainable score, and 11 of the 16 marshes scored above the 50th percentile, indicating that the majority of our study marshes provide significant habitat value to terrestrial wildlife.
- Species richness (r^2 = 0.24, F = 4.53, p = 0.05) and abundance (r^2 = 0.26, F = 5.00, p = 0.04) of Ardeids significantly increased with increasing assessment score, from which we can infer reasonable confidence in our assessment for these species.
- We demonstrate that optimized models can be helpful in improving the accuracy of the assessment for a given species or species assemblage.

Impacts and Outcomes

The AED wetland research efforts resulted in a partnership with EPA Region 1 and the Massachusetts Coastal Zone Management to implement a southern New England rapid assessment program to assess coastal wetlands in CT, MA, and RI. The southern New England rapid assessment program is one of a few national case studies using the three-tiered approach to assess the condition of wetlands. EPA's Office of Research and Development is working with the Office of Water, the New England States, the mid-Atlantic States, California, and mid-western states to develop and apply these wetland assessment methods broadly. The three-tiered assessment approach provides inventories of wetland resources, mitigation and restoration site identifications, 305(b) condition assessments, and reports on the quality and quantity of the wetlands. Furthermore, the methods will provide for assistance in developing tiered aquatic life use support criteria for coastal wetlands. Indeed, AED's research has provided a sound scientific foundation for the EPA Office of Water (OW) wetland assessment guidance recently provided to the States (US EPA, 2006) and for the development of methods and sampling design for the OW National Wetland survey of condition scheduled for 2011. Use of these methods will help to maintain the quality and quantity of the Nation's coastal wetlands.

Future Directions

Analyses of the landscape, plant, and soils rapid assessment data are underway. After statistical analyses of these data are completed, recommendations for improving the rapid assessment methods and future implementations will be made. The rapid assessment approach appears to be successful in detecting differences in above-ground plant structure among coastal wetlands with varying watershed development and disturbance.

Research to examine the soil structure including root and peat volume, and changes in soil respiration when salt marshes are subject to varying nitrogen loads are also underway. CAT scan imaging is being used to describe the marsh soil structure and a portable infrared detector to measure CO_2 efflux. These measures will help verify and calibrate the rapid assessment soil methods.

An evaluation scheme for assessing the condition of the coastal wetlands will be developed and calibrated after data analyses are completed. Empirical studies will continue to ground-truth selected wildlife-habitat relationships and also aid in developing stressor-response models between populations of avifauna and the quality or condition of the salt marshes.

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